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SpaceX Satellite Constellations

Anju Babu
Portland State University

Kevin Camp
Portland State University

Wray Price
Portland State University

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SpaceX Satellite Constellations

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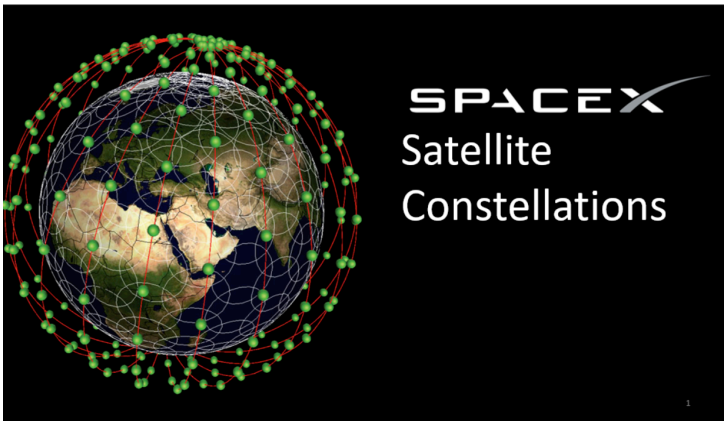
Author(s): Team 3
Anju Babu (anjub@pdx.edu)
Kevin Camp (kcamp@pdx.edu)
Wray Price (wprice@pdx.edu)



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Report No.:
Type: Student Project
Note:

Purpose

As of June 2017, only 51% of people worldwide have access to the internet. The goal of this project is to deploy the world's first global satellite internet service capable of servicing both internet backbone infrastructure and end consumers across the globe.

Founded in 2002 SpaceX has revolutionized the space launch industry, with the end goal of making Humans a multi planetary species. This effort requires significant funding resources, which has led to the pursuit of business opportunities beyond the launch market where SpaceX currently does the majority of its business. By providing global internet coverage, SpaceX stands to make a profit of $15 Billion by 2025, proving the funding necessary to further the company's long term goals.

The FCC has approved the proposal to deploy 4,425 satellites into 83 different low earth orbital planes. It is stipulated in this approval is that 50% of the constellation must be deployed within 6 years, with the remaining deployed within 9 years. These deployment timelines imposed by the FCC are critical to the success of the full constellation. Failure to meet these deadlines could result in the revocation of the operating license, and a loss of all investments made in the development, production and deployment of the constellation.

Objectives

The objective of this project is to launch and successfully deploy the prototype satellites into orbit. The project team headed by the Project Manager has prepared a baseline schedule and budget for the project. The project start date is Monday, January 1st, 2018 and takes 109 working days to finish. Any delay in the baseline schedule results in the extension of the extended project. This affects the regulatory compliance, revenues, competitive advantage and reputation of the firm. Thus, it is a mission and time-critical project which needs constant monitoring and evaluation.

The resources are highly skilled and a part of different functional teams within the matrix organization. The utilization of these resources at their available time is another critical factor. Being a developmental space mission, the project is prone to many uncertainties and catastrophic risks. A proper risk mitigation strategy has to be in place to ensure quality, schedule and cost compliance.

Overview

Satellite constellation is a development project in SpaceX. Being an Aerospace company, this project aligns perfectly with the vision and mission of the organization. It is a highly publicized project with big payoffs for the company as well as its customers because when implemented successfully, it has the potential to revolutionize internet communications. The revenue generated is huge too: $30 billion by 2025, which is 6 times the size of SpaceX’s rocket business, which is currently the bread and butter of the organization. The regulatory agencies and competitors are looking forward to the developments as well.

The satellite internet project falls under the Satellites division, which is separate from the rest of the functional divisions, and is headed by a Vice President, who reports to the CIO, who further reports to the CEO (see Appendix A for Organizational structure). The whole of Satellites division follows a matrix structure which has both functional and projectized groups, closely interrelated. There are functional teams that have expertise in the technology and processes, as well different project teams to look after the various stages of deployment. The project team works in conjunction with other teams in the Satellite, Rockets, Manufacturing, Human Resources, Legal and Public Relations divisions. For limited time periods, resources are allocated from each of these teams to the project. Some of the activities are outsourced to other internal teams.

The major deliverables are procurement and maintenance of satellites and rockets, manufacturing and testing of payload adapter, system integration, obtaining regulatory licensing, launch and deployment of satellites (see Appendix B for WBS).
Our assumptions are listed below:

- Most of the manufacturing facilities and utilities are already available in the organization, except the payload adapter.
- The project is billed separately for the resources that they procure from and outsource to the other internal departments.
- The resources have the required skills for carrying out the project responsibilities. Any additional training or skill requirement is considered in the stakeholder communication.
- The costs for consulting function is attributed as a part of the other direct responsibilities of a resource and are not billed separately.
- The project environment is a highly automated one and most of the safety and quality aspects are taken care of by highly advanced sensors and automatic maintenance.

The baseline schedule and program budget are adjusted with the risks.

Schedules

The project is scheduled to start on January 1st, 2018 and end on May 21st, 2018 with a 102 day duration. The schedule was derived using PERT effort calculation (see Appendix F) on the critical path from the Activity on Node (AON) diagram (see Appendix G) and by using 3-point estimate method. The resource availability was considered and resource load leveling was done (see Appendix K). The available slack times were considered and the project was re-baselined to finish in 109 working days on May 31st, 2018 (see Appendix I). The probability of project completion on this date is 94% as derived from the probability diagram.

Certain milestones have been determined for the project to track the progress. These are critical events that serve as a reference point to ensure that the project is monitored and controlled in terms of time or cost or quality.

- Milestone 1: Rocket procurement
- Milestone 2: Satellite procurement

- Milestone 3: Specification checks & testing of rockets
- Milestone 4: Specification checks & testing of satellites
- Milestone 5: Install satellites onto payload adapter
- Milestone 6: Preparation for launch

The schedule reserve is calculated considering the risks encountered and an additional 8 days are added to the project baseline.

Resources

The total budget of the project, including the risk reserve is $60.3 million. This includes the capital costs as well as the human resources cost. A bottom-up approach using the PERT effort table (see Appendix F) was used for cost calculations and the baseline budget. The material cost totaled to $57.5 million and the 61 personnel cost to $1 million for 2100 labor hours over 109 days (see Appendix L).

The rockets and satellite production are outsourced to other departments and only the design specifications and testing need to be done as part of the project. The project team takes on the entire design and manufacturing functions of the payload adapter including the procurement and testing activities.

The table below gives a brief summary of each resource / resource groups in this project:

Resource / Resource Groups	Major Responsibilities
Project Manager	Heads the project and is accountable for the project success and final delivery. He/she is responsible for a variety of tasks and is the primary person responsible for the project coming in on time and within budget.
Manufacturing	The manufacturing team will manufacture the payload adapter based on the specifications given by the design team.
Rocket Design	The rocket design team provides a set of specifications for the payload adapter as it mounts directly to the rocket.
Satellite Design	The satellite design team provides the specifications for the satellite and the payload adapter.
Launch	The launch group is primarily responsible for preparing for and performing the rocket launch. They are involved in ensuring the safety of the facilities and quality of all the equipment and tools used for launch.
Satellite Operations	The satellite operations group are responsible for operation of the satellites once they are deployed into orbit.
Test	The test team carries out any testing necessary on the rocket, satellites, and payload adapter.
Public Relations	The public relations team interacts with the external stakeholders that are not involved with the project in a regulatory capacity. They are responsible for collecting reports from specific teams, maintaining the

	confidential documents, hosting relevant data on website, social media and disseminating information to the stakeholders.
HR	The human resources team is responsible for employee induction, compensation, training, record keeping and motivation.
Legal	The legal team advise the project team and management on the regulatory and governmental compliance.

For each activity, there is one resource accountable for the completion of each deliverable or task. This is the personnel that has to approve and sign off the output of the task. There could be one or more resources responsible for carrying out the task and they turn in their work in the end to the accountable person. On top of this, there are personnel whose expertise can be utilized for consulting for each task. Some personnel need to be informed on the status and outcome of a task. The activities of each person and the number of hours they spend on each task is listed on the RACI matrix (see Appendix D) and PERT effort sheet (see Appendix F) respectively.

So as to keep up within the schedule, overloaded resources are found out and the tasks are evenly distributed among the resources at any given time. After resource leveling, it is ensured that no resource is utilized more than 100% at any given period (see Appendix K).

Stakeholders

Based on the power and interest of the stakeholders associated or affected by this project, the communication strategies for stakeholder communication can be decided.

The project is a high profile one and has harbored significant attention from worldwide communication and media agencies. Therefore, an entire team is dedicated for the external communications. Internally, it is important to keep the team morale high considering the critical nature of the project. Thus, stakeholder communication spans over the entire length of the project for about 190 hours of effort (see Appendix B for the frequency and mode of communication). This also includes any additional training required for the employees for specific tasks.

Risk Management

The space research and development is a highly risk-prone filed with many unknowns. Although the organization is experienced in carrying out risky projects and operations in the past, having no particular model to look up for the deployment of satellites in the lower earth orbits pose new risks. The risks are independent of each other and thus, can be analyzed without any interdependencies. Here are a few identified risks along with their contingency plans (see Appendix E):

- There is a 3 % chance of a catastrophic launch failure. Should this occur the company will need to pay an estimated $60 million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay. This risk is accepted due to the low likelihood of it occurring, and the high cost of insurance

to transfer the risk (8.5 million). The budget reserve for this is $1.8 million and the schedule reserve is 3.6 days.

- There is a 4% chance of unrecoverable damage occurring to the satellites once in orbit. Should this occur the company will need to pay an estimated $60 million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay. This risk is transferred by buying a satellite on orbit insurance that costs 5% of the project cost, i.e. 3 million. As the risk is already transferred, there is no requirement of budget reserve. However, a schedule reserve of 4.8 days is required.

- There is 50% chance of shock and vibration damage occurring during the launch of the satellites. This damage would render the satellites only partially functional costing $30 million in schedule delays for future operations. By performing shock and vibration testing the engineers can mitigate this risk by ensuring damage will not occur during launch. The test equipment costs $200,000 and the activity requires 3 days from the schedule.

- There is a 10% chance that the shock and vibration test equipment is out of tolerance and could damage the satellites during testing. If this damage occurs, one satellite will need to be replaced at a cost of $1.5 million, causing a 35 day schedule delay to receive a replacement. This risk is mitigated by performing maintenance and calibration of the test equipment. This costs $25,000 and 1.8 days of activities. There are no risk reserves required, thanks to the failsafe testing.

- There is a 30% chance that electrostatic discharge (ESD) damage could occur to the satellites during integration activities. This damage would render the satellites inoperable once in orbit. Should this occur the company will need to pay an estimated $60 million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay. This risk can be mitigated by performing additional, destructive ESD testing on an additional satellite. The testing is carried out on a test satellite that costs $1.5 million and 1.2 days.

The cost of risk avoidance activities is $4.725 million and takes 6 working days. Due to accepted risks, the budget requires a reserve of $1.8 million and the schedule a reserve of 8.4 days.

Evaluation Methods, Monitoring and Control

The projects have to comply with the standards mandated by the regulatory authorities such as FCC and ITU. The certifications from these authorities and others such as ISO/TC 20/SC 14 and TR-34 provide specifications that the project should follow in terms of quality. FCC has also mandated a deadline for the project and the project planning has been updated accordingly.

The regulatory authorities and certification agencies conduct safety and quality audits. There will be internal project audits as well, at each milestone. These audits are well laid out and has to affirm that the project is on track in terms of schedule, cost and quality.
Most of the deliverables or system outputs are monitored using cybernetic controls. Advanced sensors and automated machines enable the technical, maintenance and manufacturing processes. The outputs are compared against the simulation results for ensuring quality outputs. Any anomaly detected would be investigated according to the risk probability and impact.

A project meeting is convened at the end of each week and the project manager collects status updates from the representatives of each team. Once an earned value analysis is done, cost and schedule adherence are checked and the cost performance index (CPI) and schedule performance index (SPI) are calculated. A 50-50 rule is applied for estimating the schedule completion of tasks.

The SPI will be calculated based on the completed tasks in for a period of time divided by the expected completion date in the final baseline schedule. The CPI will look at the actual cost of the project every week and divide that by the time phased budget to get a value. Ignore for both charts will not be discussed in length with upper management or the functional managers for SPI or CPI. Monitor closely will require detailed reports weekly for both indexes along with a plan to get back on track. Investigate will have the PM try to discover why the index is so high and determine the root cause. Meet with board will require a meeting between management, the functional manager and the PM each week with a score in that range (see Appendix M for the ranges).

Termination

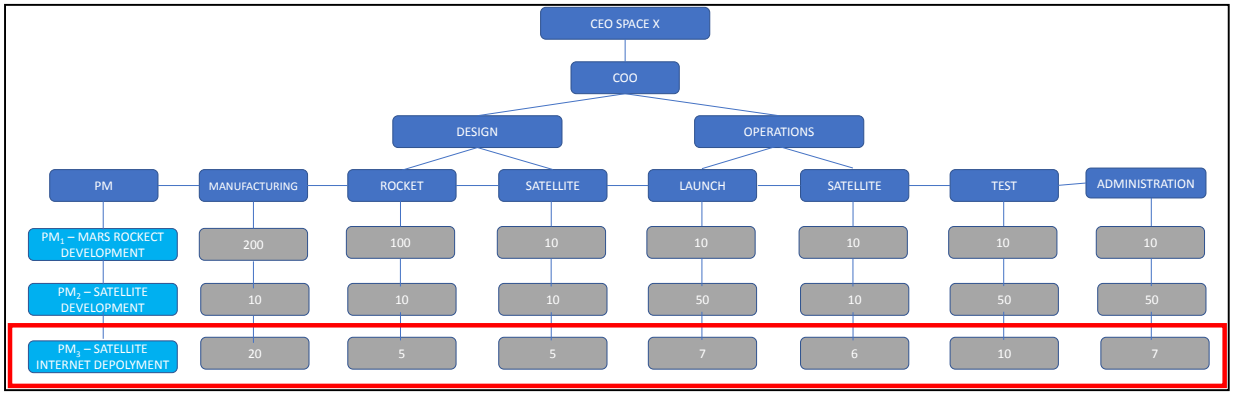
The last task of the project is termination by integration. If this development project is successfully completed, i.e. communication is established with the satellites after reaching and sustaining the specified orbit. The project team will be deployed into this new project mission and will carry out similar or higher functionalities according to their expertise gained from the project.

The responsibility of the deployed satellites and the functionalities are handed over to the extended team of satellites operations team. The functional manager of the team checks the bandwidth, latency, battery consumption and area coverage of the satellites and signs off the documents. The approved documents are reviewed by the Vice President of the Satellites team, who then provides the final sign off for the successful completion of the project.

The technical documentation required for the regulatory authorities are shared as part of the compliance process and the PM shares the complete project report along with the performance indexes and evaluation results to the relevant internal teams. The public relations team publishes the updates on website and social media. Human resources team removes the project team from the project-related payroll and reassigns them to the new project or others, depending on the criticality of the different future projects.

Appendices

A: Organizational Chart

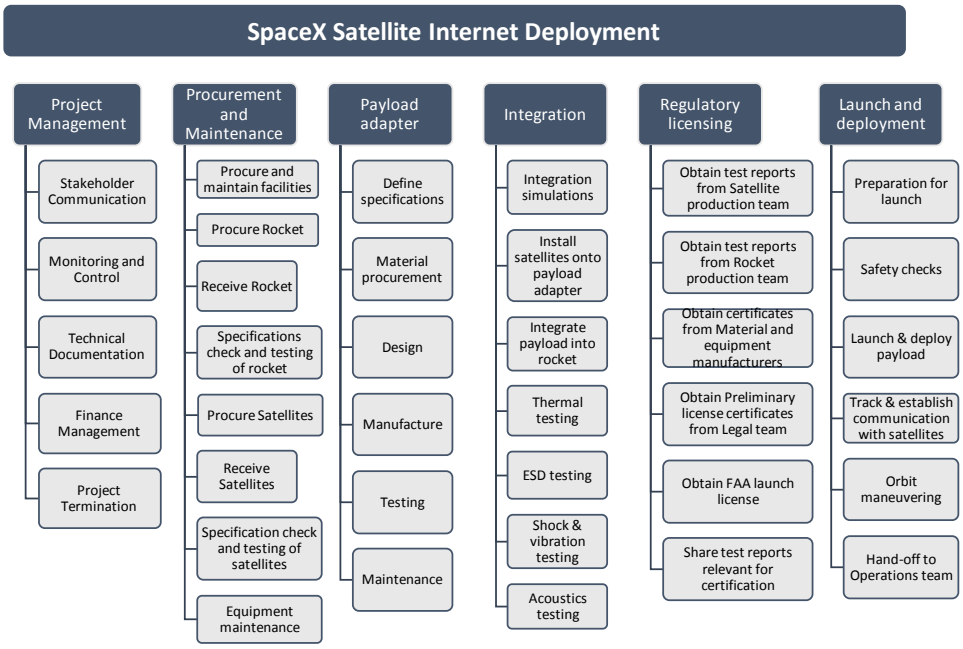


B: Stakeholders

Stakeholders	Power	Interest	Communication medium	Frequency	Effort requirement (hours)
External					
UN	H	H	Meetings, Presentations, email	Monthly	100
Government	H	H	Meetings, email	Monthly	50
Military	H	H	Meetings, email	Quarterly	50
Regulatory agencies	H	H	Legal documents, Meetings	Once	200
Media	L	H	Interviews, Telephone, email	Weekly	25
Environmentalists	L	L	Webstite, email	Weekly	10
Competitors	L	H	Meetings, email	Monthly	10
Internet providers	H	L	Meetings, Presentations, email	Quarterly	25
Social media	H	L	Meetings, Presentations, email	Quarterly	10
Other Partners	L	L	Webstite	Monthly	10
End consumers	L	H	Website	Monthly	15

Stakeholders	Power	Interest	Communication medium	Frequency	Effort requirement (hours)
Internal					
Founder shareholders	H	H	email updates	Monthly	0.5
Other investors	H	H	email updates, Web updates in Investor section	Quarterly	1
Project members	H	H	emails, Telephone, Handheld device notifications	Daily	1
			Meetings	Weekly	2
Project managers	H	H	emails, Telephone, Handheld device notifications	Daily	1
			Meetings	Weekly	5
Administrators	L	L	emails, Telephone	Daily	5
Department heads	H	L	emails, Telephone	Weekly	4
			Meetings	Montly	3
Other employees	L	L	email newsletters, flyers	Monthly	2

C: Work Breakdown Structure (WBS)



D: RACI Matrix

				Design		Operations				
Level 2	Task	PM	Manufacturing	Rocket	Satellite	Launch	Satellite	Test	Public Relations	HR and Legal
Project Management	Stakeholder Communication	R							A	C
Project Management	Monitoring and Control	A								
Project Management	Technical Documentation	R		R	R			R		A
Project Management	Finance Management	A								C
Project Management	Project Termination	A								
Procurement and Maintenance	Procure and maintain facilities	R		A		R				C
Procurement and Maintenance	Procure Rocket	R	R	R		A				
Procurement and Maintenance	Recieve Rocket	R	R			A				
Procurement and Maintenance	Specifications check and testing of rocket	R	I	A				R		
Procurement and Maintenance	Procure Satellites	R	R		R		A			
Procurement and Maintenance	Receive Satellites	R	R				A			
Procurement and Maintenance	Specification check and testing of satellites	R	I		A			R		
Procurement and Maintenance	Equipment maintenance	R		C		A				
Payload adapter	Define specifications	R	C	R	A			I		
Payload adapter	Material procurement	R	A	I						C
Payload adapter	Design	R	C	A	C	I		C		
Payload adapter	Manufacture	R	A	C				I		
Payload adapter	Testing	R		C		I		A		
Payload adapter	Maintenance	R	A	C		I				
Integration	Integration simulations	R		A				R		
Integration	Install satellites onto payload adapter	R		C		A				
Integration	Integrate payload into rocket	R				A	C			
Integration	Thermal testing	R			C			A		
Integration	ESD testing	R			C			A		
Integration	Shock & vibration testing	R			C			A		
Integration	Acoustics testing	R			C			A		
Regulatory licensing	Obtain test reports from Satellite production tea	R	R		C			C		A
Regulatory licensing	Obtain test reports from Rocket production team	R	R	C				C		A
Regulatory licensing	Obtain certificates from Material and equipment manufacturers	R	R							A
Regulatory licensing	Obtain Preliminary license certificates from Legal team	R				I	I			A
Regulatory licensing	Obtain FAA launch license	R				I				A
Regulatory licensing	Share test reports relevant for certification	R						C		A
Launch and deployment	Preparation for launch	R				A	R		R	
Launch and deployment	Safety checks	R				A				
Launch and deployment	Launch & deploy payload	R				A	C		R	
Launch and deployment	Track & establish communication with satellites	R				A	C			
Launch and deployment	Orbit maneuvering	R				A	C			
Launch and deployment	Hand-off to Operations team	R				A	R			

E: Risk Assessment

Risk	Catastrophic Launch Failure
Risk Impact Statement	There is a 3 % chance of a catastrophic launch failure. Should this occur the company will need to pay an estimated $60million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay.
Risk Response Strategy	This risk is accepted due to the low likely hood of it occurring, and the high cost of insurance to transfer the risk (8.5 million)
Cost to mitigate or transfer risk	N/A
Risk Reserve	Budget reserve = 0.03*$60million = 1.8Million Schedule reserve = 0.03*120 days = 3.6 days

Risk	Satellites destroyed in orbit before handoff
Risk Impact Statement	There is a 4% chance of unrecoverable damage occurring to the satellites once in orbit. Should this occur the company will need to pay an estimated $60 million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay.
Risk Response Strategy	By purchasing satellite on orbit insurance this risk will be transferred.
Cost to mitigate or transfer risk	Insurance costs 5% of coverage 0.05*$60million= $3 million.
Risk Reserve	Thanks to risk transfer, we expect no budget impact from this risk occurring Budget reserve = 0.04*$0 = $0 This does not account for the possible schedule delay however. Schedule reserve = 0.04*120 days = 4.8 days

Risk	Shock and vibration damage to payload during launch.
Risk Impact Statement	There is 50% chance of shock and vibration damage occurring during the launch of the satellites. This damage would render the satellites only partially functional costing $30 million in schedule delays for future operations.
Risk Response Strategy	By performing shock and vibration testing the engineers can mitigate this risk by ensuring damage will not occur during launch.
Cost to mitigate or transfer risk	200K for test equipment 3 days of testing
Risk Reserve	Thanks to risk mitigation, we have reduced the likelihood of this risk occurring to 0%. Thus we do not need a budget or schedule reserve for this risk.

Risk	Shock and vibration equipment is out of tolerance
Risk Impact Statement	There is a 10% chance that the shock and vibration test equipment is out of tolerance and could damage the satellites during testing. Should this damage occur one satellite will need to be replaced at a cost of $1.5 million, causing a 35 day schedule delay to receive a replacement.
Risk Response Strategy	By performing maintenance and calibration of the test equipment this risk can be fully mitigated
Cost to mitigate or transfer risk	25K for test equipment 1.8 days of calibration
Risk Reserve	Thanks to risk mitigation, we have reduced the likelihood of this risk occurring to 0%. Thus we do not need a budget or schedule reserve for this risk.

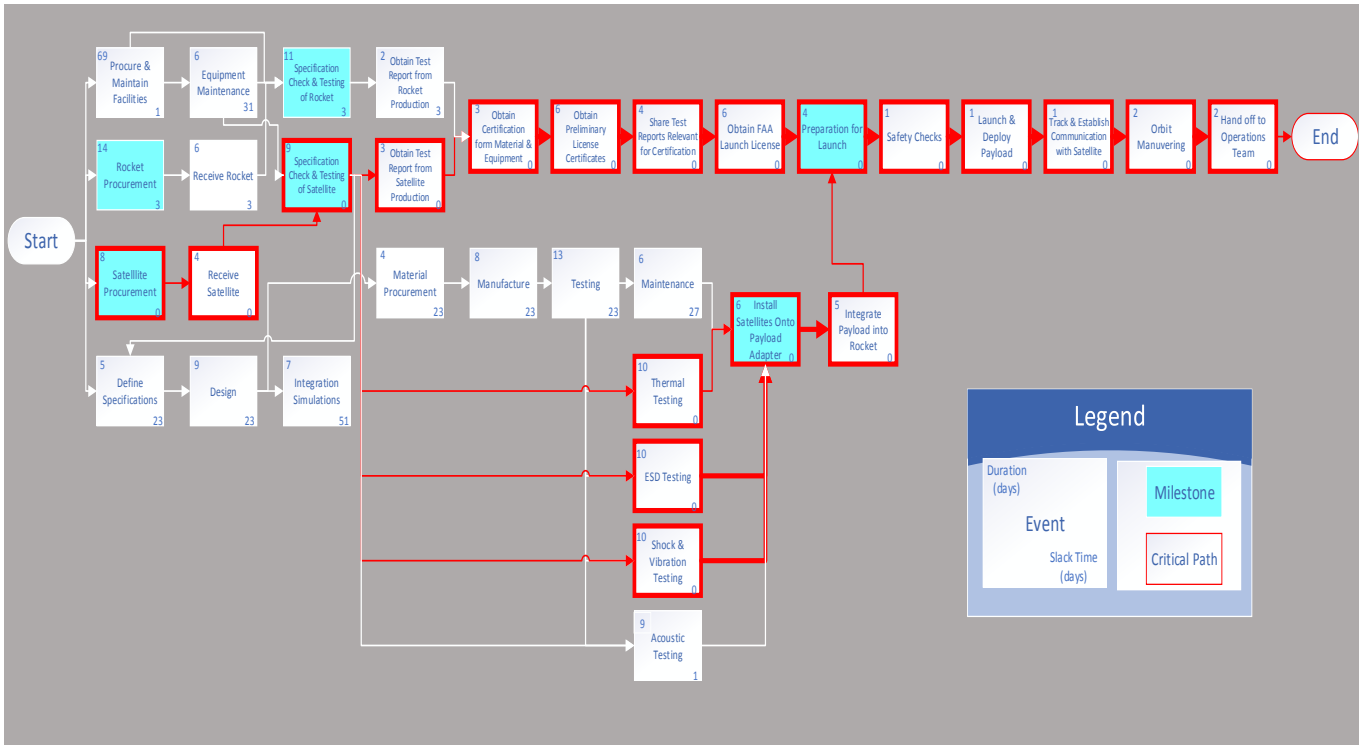
Risk	Satellites damaged during integration with payload adapter
Risk Impact Statement	There is a 30% chance that ESD damage could occur to the satellites during integration activities. This damage would render the satellites inoperable once in orbit. Should this occur the company will need to pay an estimated $60 million to reproduce the project's effort's a second time, with an additional 120 day of schedule delay.
Risk Response Strategy	This risk can be mitigated by performing additional, destructive ESD testing on an additional satellite.
Cost to mitigate or transfer risk	Additional satellite for testing purposes: $1.5million 1.2 days are required to perform the testing. (See ESD testing task in the schedule)
Risk Reserve	Thanks to risk mitigation, we have reduced the likelihood of this risk occurring to 0%. Thus we do not need a budget or schedule reserve for this risk.

Totals	Cost to mitigate or transfer risk
	Total budget cost: $4.725 million Total schedule impact: 6 days
	Risk Reserve
	Budget risk reserve total: $1.8 million Schedule risk reserve total: 8.4 days

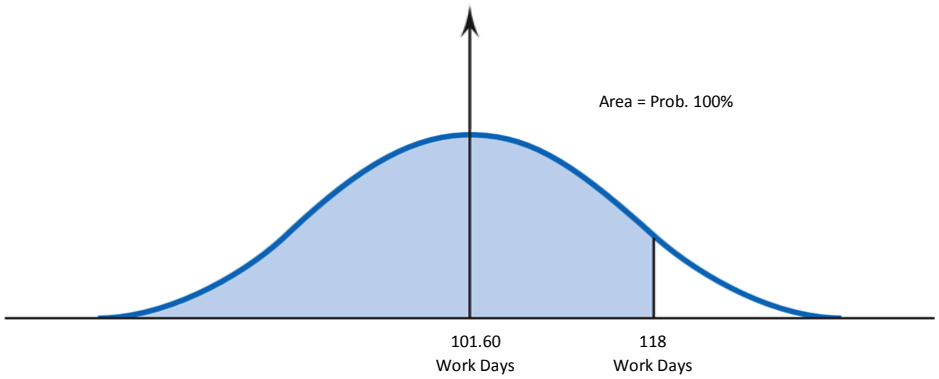
F: PERT Effort Summary

Task	Scheduled Duration	Task Variance	Is Critical Path	Critical Path Variance	Critical Path time	Material costs	Labor Cost
Start							
Stakeholder Communication	20.00	2.78	FALSE	0.00	0.00	$ -	$ 15,666.67
Monitoring and Control	15.00	2.78	FALSE	0.00	0.00	$ -	$ 6,000.00
Technical Documentation	5.33	1.00	FALSE	0.00	0.00	$ -	$ 80,400.00
Finance Management	7.17	0.69	FALSE	0.00	0.00	$ -	$ 2,866.67
Project Termination	4.00	0.11	TRUE	0.11	4.00	$ -	$ 1,600.00
Procure and maintain facilities	7.17	0.69	FALSE	0.00	0.00	$ 50,000.00	$ 42,400.00
Procure Rocket	9.67	0.44	FALSE	0.00	0.00	$ 40,000,000.00	$ 81,433.33
Recieve Rocket	4.00	0.11	FALSE	0.00	0.00		$ 35,333.33
Specifications check and testing of rocket	4.00	0.11	FALSE	0.00	0.00	$ 350,000.00	$ 40,200.00
Procure Satellites	7.00	0.44	TRUE	0.44	7.00	$ 15,000,000.00	$ 95,833.33
Receive Satellites	3.83	0.25	TRUE	0.25	3.83		$ 35,333.33
Specification check and testing of satellites	5.33	1.00	TRUE	1.00	51.76	$ 150,000.00	$ 62,866.67
Equipment maintenance	5.00	0.00	FALSE	0.00	0.00	$ 25,000.00	$ 24,066.67
Define specifications	3.83	0.06	FALSE	0.00	0.00	$ -	$ 61,866.67
Material procurement	3.00	0.11	FALSE	0.00	0.00	$ 15,000.00	$ 12,466.67
Design	7.17	0.69	FALSE	0.00	0.00	$ -	$ 57,533.33
Manufacture	7.50	1.36	FALSE	0.00	0.00	$ 3,000.00	$ 30,200.00
Testing	12.17	0.69	FALSE	0.00	0.00	$ 5,000.00	$ 48,866.67
Maintenance	1.83	0.03	FALSE	0.00	0.00	$ 500.00	$ 7,366.67
Integration simulations	6.50	0.69	FALSE	0.00	0.00	$ -	$ 44,866.67
Install satellites onto payload adapter	5.50	1.36	TRUE	1.36	5.50	$ -	$ 26,833.33
Integrate payload into rocket	3.83	0.25	TRUE	0.25	3.83	$ -	$ 18,833.33
Thermal testing	2.17	0.03	TRUE	0.03	2.17	$ 500.00	$ 8,866.67
ESD testing	1.17	0.03	TRUE	0.03	1.17	$ 1,500,000.00	$ 4,866.67
Shock & vibration testing	3.00	0.11	TRUE	0.11	3.00	$ 200,000.00	$ 12,200.00
Acoustics testing	3.00	0.11	FALSE	0.00	0.00	$ 5,000.00	$ 12,200.00
Obtain test reports from Satellite production tea	1.00	0.00	TRUE	0.00	1.00	$ -	$ 7,600.00
Obtain test reports from Rocket production team	1.00	0.00	FALSE	0.00	0.00	$ -	$ 7,600.00
Obtain certificates from Material and equipment manufacturers	2.00	0.11	TRUE	0.11	2.00	$ -	$ 12,133.33
Obtain Preliminary license certificates from Legal team	5.00	0.44	TRUE	0.44	5.00	$ -	$ 16,400.00
Obtain FAA launch license	3.17	0.25	TRUE	0.25	3.17	$ -	$ 5,000.00
Share test reports relevant for certification	2.00	0.11	TRUE	0.11	2.00	$ -	$ 4,533.33
Preparation for launch	3.00	0.11	TRUE	0.11	3.00	$ 250,000.00	$ 29,720.00
Safety checks	0.25	0.00	TRUE	0.00	0.25	$ -	$ 1,300.00
Launch & deploy payload	0.25	0.00	TRUE	0.00	0.25	$ -	$ 1,480.00
Track & establish communication with satellites	0.50	0.00	TRUE	0.00	0.50	$ -	$ 2,600.00
Orbit maneuvering	1.00	0.00	TRUE	0.00	1.00	$ -	$ 5,200.00
Hand-off to Operations team	1.17	0.03	TRUE	0.03	1.17	$ -	$ 10,066.67
				Critical Path Variance	Critical Path duration	Total Material Cost	Total Labor Cost
				4.64	101.60	$ 57,554,000.00	$ 974,600.00

G: Activity on Node (AON) Diagram



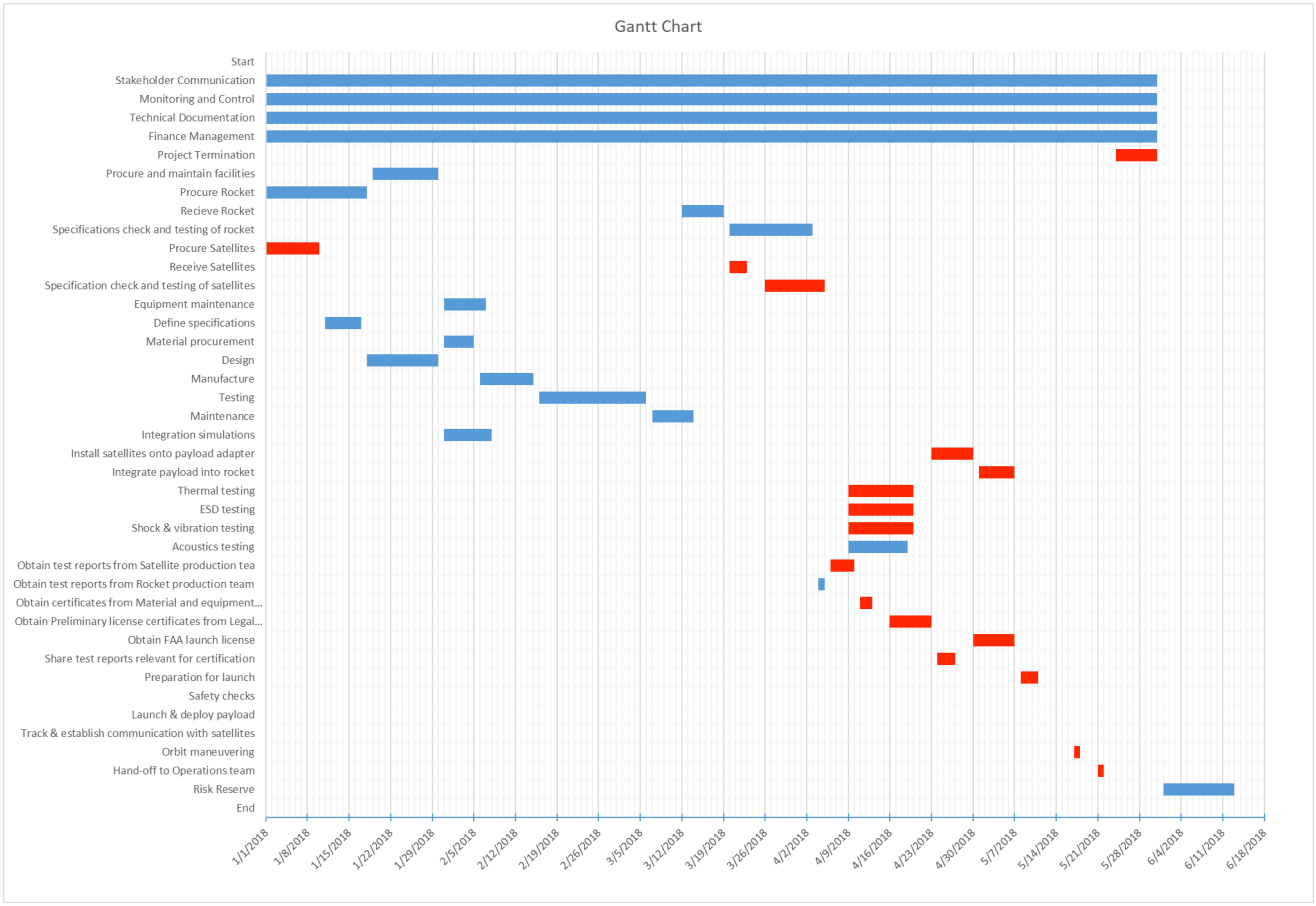
H: Schedule Probability Diagram



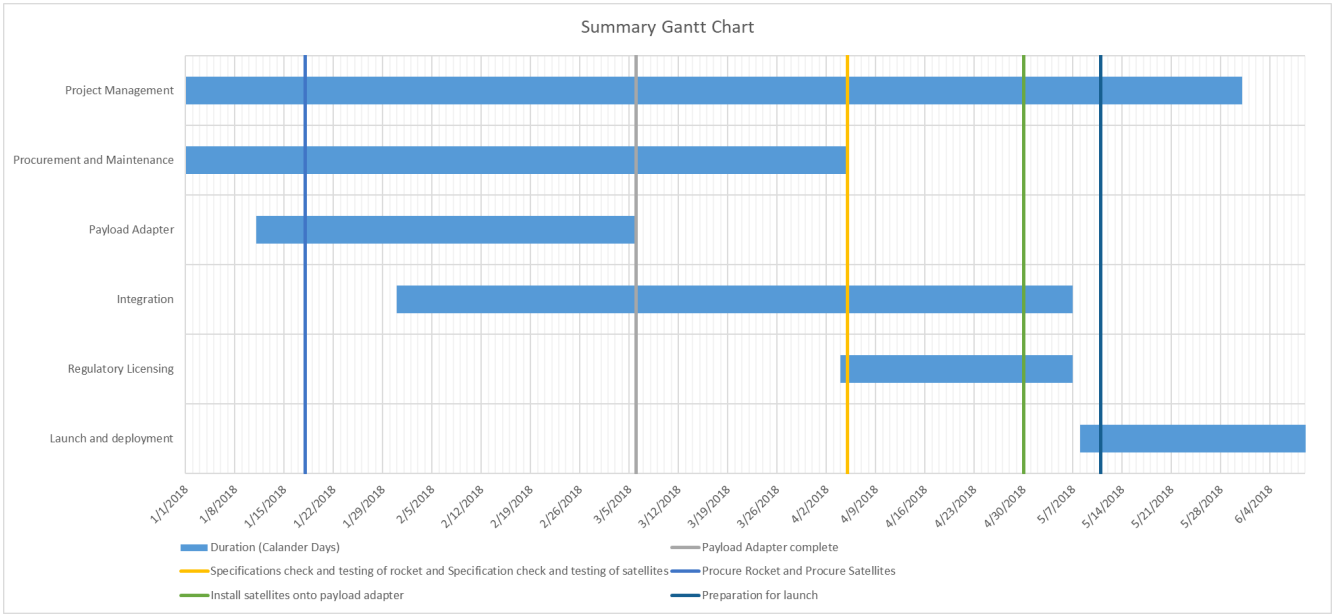
Original Schedule		Load Leveled Schedule	
D (desired project Completion Time)	99	D (desired project Completion Time)	118
u (critical time of the project)	101.60	u (critical time of the project)	101.60
Z	-0.56	Z	3.54
Likely hood of on time completion	**29%**	Likely hood of on time completion	**100%**

I: Baseline Schedule

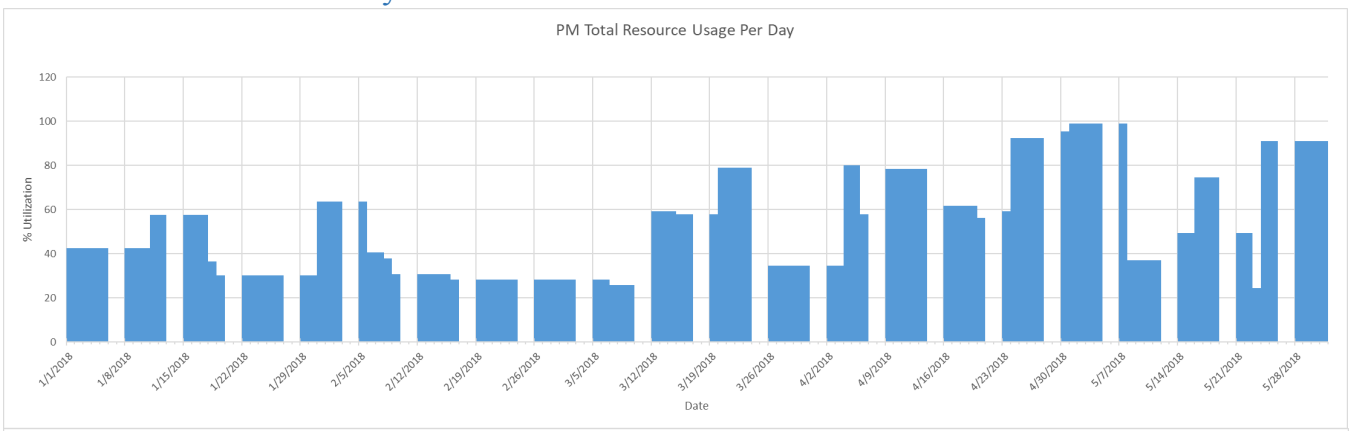
Activity	Task	Minimum Duration (Work	Planned Duration (Work Days)	Predecessors	Delayed Start (Work Days)	Stretch Duration (days)	Delay Start (Days)	Start Date	End Date	Calendar Duration
0	Start	0.0	0.0		0	0	0	1/1/2018	1/1/2018	0
1	Stakeholder Communication	20.0	109.0	0	0	88	0	1/1/2018	5/31/2018	150
2	Monitoring and Control	15.0	109.0	0	0	93	0	1/1/2018	5/31/2018	150
3	Technical Documentation	5.3	109.0	0	0	103	0	1/1/2018	5/31/2018	150
4	Finance Management	7.2	109.0	0	0	101	0	1/1/2018	5/31/2018	150
5	Project Termination	4.0	6.0	38	0	1	1	5/24/2018	5/31/2018	7
6	Procure and maintain facilities	7.2	8.0	0	0	0	18	1/19/2018	1/30/2018	11
7	Procure Rocket	9.7	14.0	0	0	4	0	1/1/2018	1/18/2018	17
8	Recieve Rocket	4.0	6.0	7	50	1	0	3/12/2018	3/19/2018	7
9	Specifications check and testing of rocket	4.0	11.0	6 8 13	0	6	0	3/20/2018	4/3/2018	14
10	Procure Satellites	7.0	8.0	0	0	0	0	1/1/2018	1/10/2018	9
11	Receive Satellites	3.8	4.0	10	65	0	3	3/20/2018	3/23/2018	3
12	Specification check and testing of satellites	5.3	9.0	11 13	0	3	0	3/26/2018	4/5/2018	10
13	Equipment maintenance	5.0	6.0	6	0	0	0	1/31/2018	2/7/2018	7
14	Define specifications	3.8	5.0	10	0	1	0	1/11/2018	1/17/2018	6
15	Material procurement	3.0	4.0	16	0	0	0	1/31/2018	2/5/2018	5
16	Design	7.2	9.0	14	0	1	0	1/18/2018	1/30/2018	12
17	Manufacture	7.5	8.0	15	0	0	0	2/6/2018	2/15/2018	9
18	Testing	12.2	13.0	17	0	0	0	2/16/2018	3/6/2018	18
19	Maintenance	1.8	6.0	18	0	4	0	3/7/2018	3/14/2018	7
20	Integration simulations	6.5	7.0	16	0	0	0	1/31/2018	2/8/2018	8
21	Install satellites onto payload adapter	5.5	6.0	20 19 23 24 25 26	0	0	0	4/23/2018	4/30/2018	7
22	Integrate payload into rocket	3.8	5.0	21	0	1	0	5/1/2018	5/7/2018	6
23	Thermal testing	2.2	10.0	12 18	0	7	1	4/9/2018	4/20/2018	11
24	ESD testing	1.2	10.0	12 18	0	8	1	4/9/2018	4/20/2018	11
25	Shock & vibration testing	3.0	10.0	12 18	0	6	1	4/9/2018	4/20/2018	11
26	Acoustics testing	3.0	9.0	12 18	0	5	1	4/9/2018	4/19/2018	10
27	Obtain test reports from Satellite production tea	1.0	3.0	12	0	1	0	4/6/2018	4/10/2018	4
28	Obtain test reports from Rocket production team	1.0	2.0	9	0	0	0	4/4/2018	4/5/2018	1
29	Obtain certificates from Material and equipment manufacturers	2.0	3.0	27 28 15	0	0	0	4/11/2018	4/13/2018	2
30	Obtain Preliminary license certificates from Legal team	5.0	6.0	27 28 29	0	0	0	4/16/2018	4/23/2018	7
31	Obtain FAA launch license	3.2	6.0	30 32	0	2	0	4/30/2018	5/7/2018	7
32	Share test reports relevant for certification	2.0	4.0	30	0	1	0	4/24/2018	4/27/2018	3
33	Preparation for launch	3.0	4.0	31 22	0	0	0	5/8/2018	5/11/2018	3
34	Safety checks	0.3	1.0	33	0	0	0	5/14/2018	5/14/2018	0
35	Launch & deploy payload	0.3	1.0	34	0	0	0	5/15/2018	5/15/2018	0
36	Track & establish communication with satellites	0.5	1.0	35	0	0	0	5/16/2018	5/16/2018	0
37	Orbit maneuvering	1.0	2.0	36	0	0	0	5/17/2018	5/18/2018	1
38	Hand-off to Operations team	1.2	2.0	37	0	0	0	5/21/2018	5/22/2018	1
39	Risk Reserve	8.4	8.4	5	0	0	0	6/1/2018	6/13/2018	12
40	End	0.0	1.0	39	0	0	0	6/13/2018	6/13/2018	0

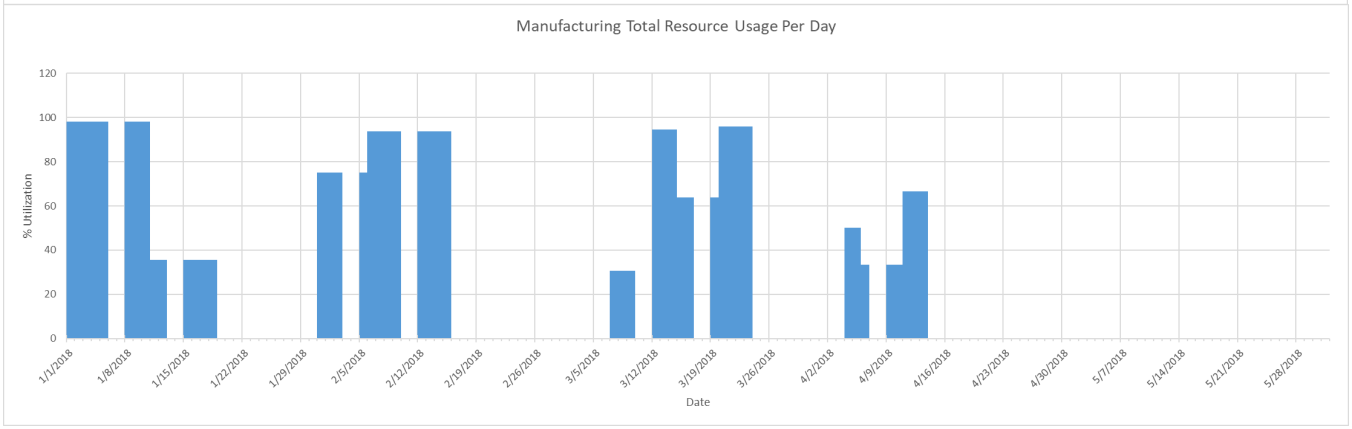


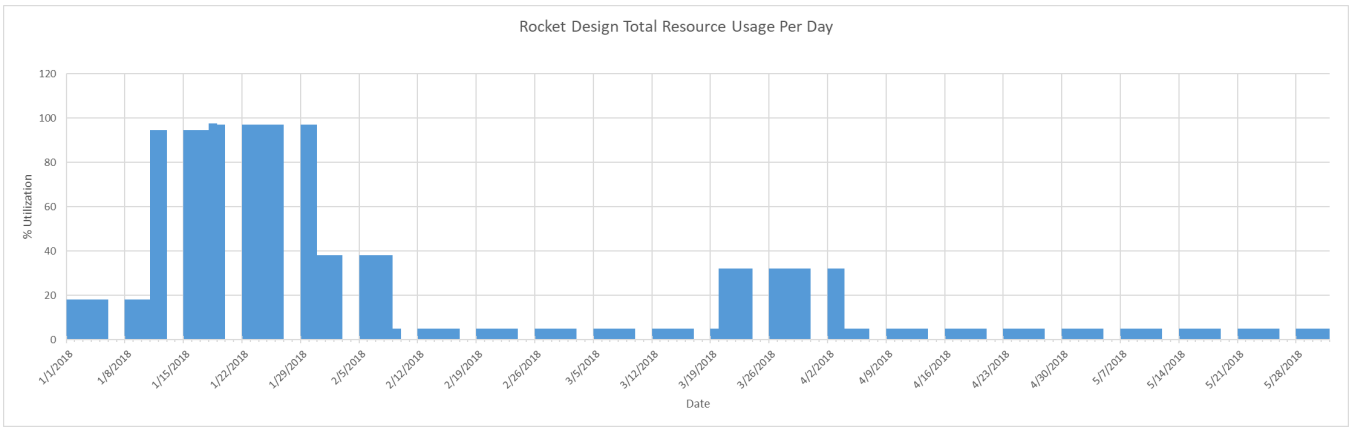
J: Summary Level Gantt Chart

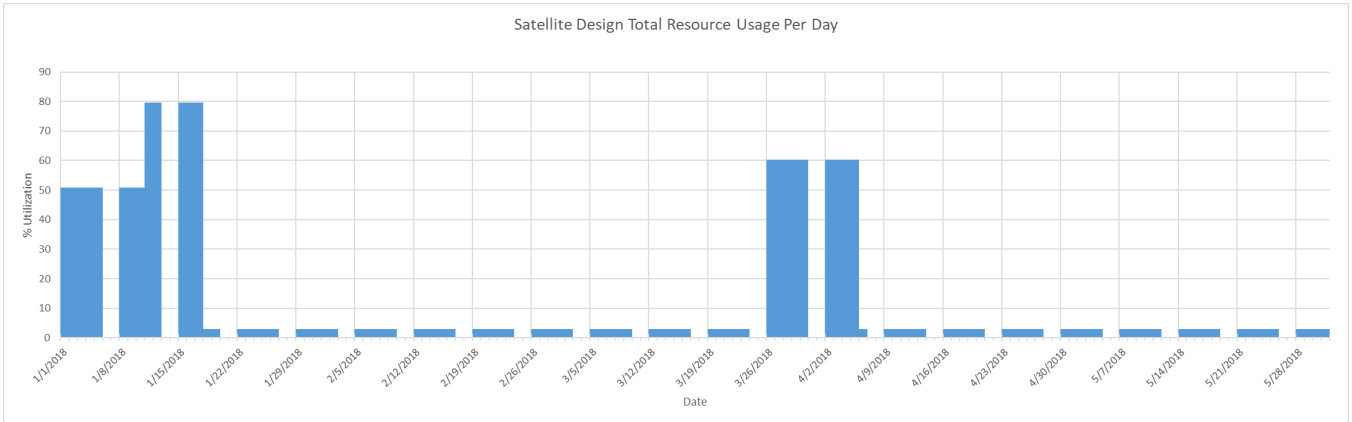


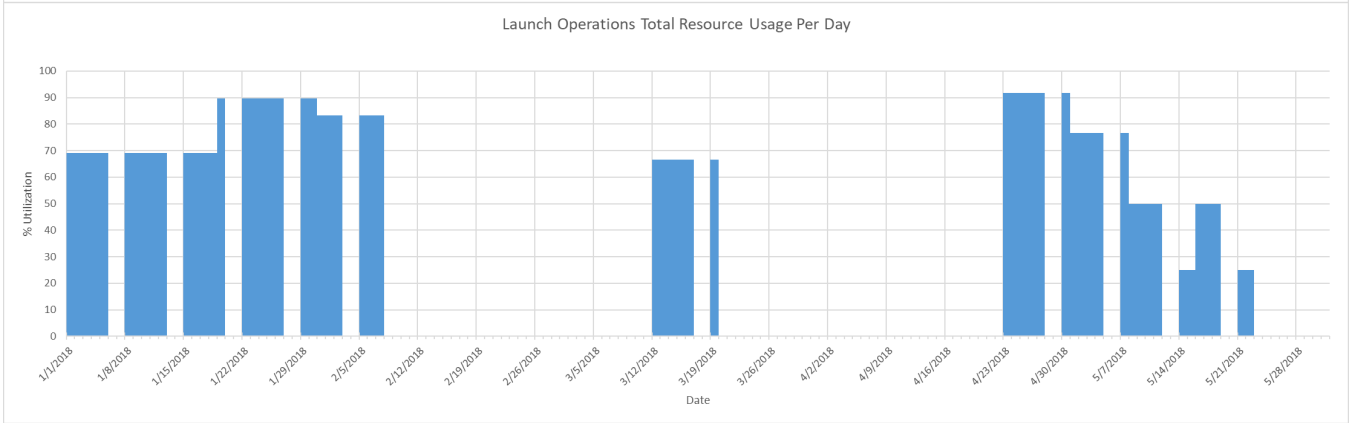
K: Resource Load Summary

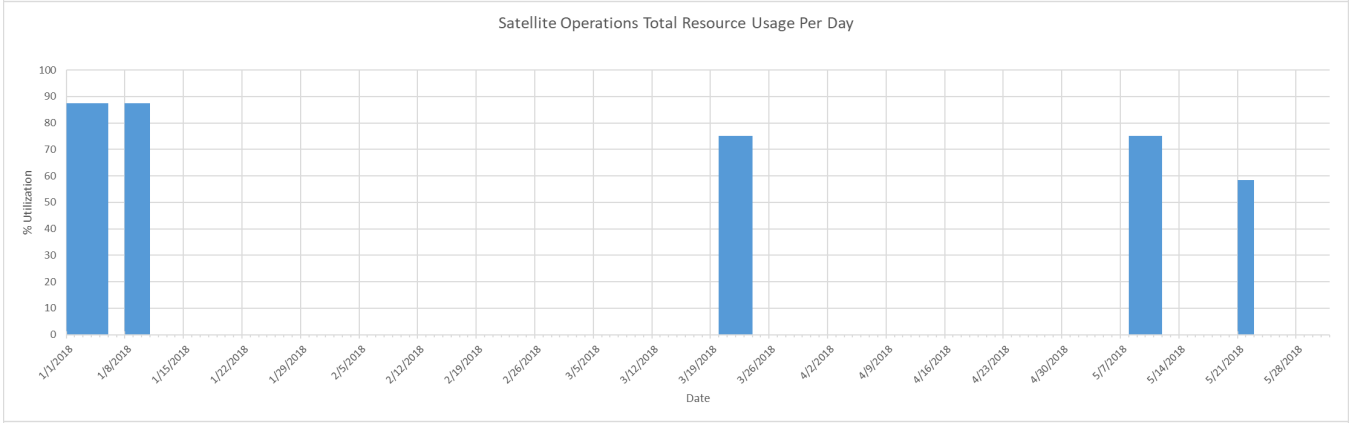


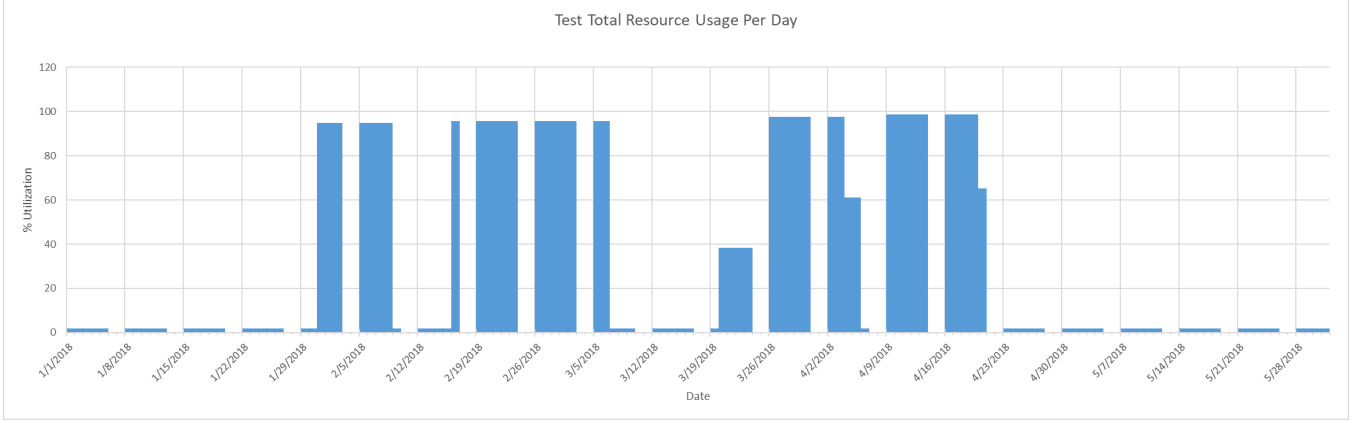


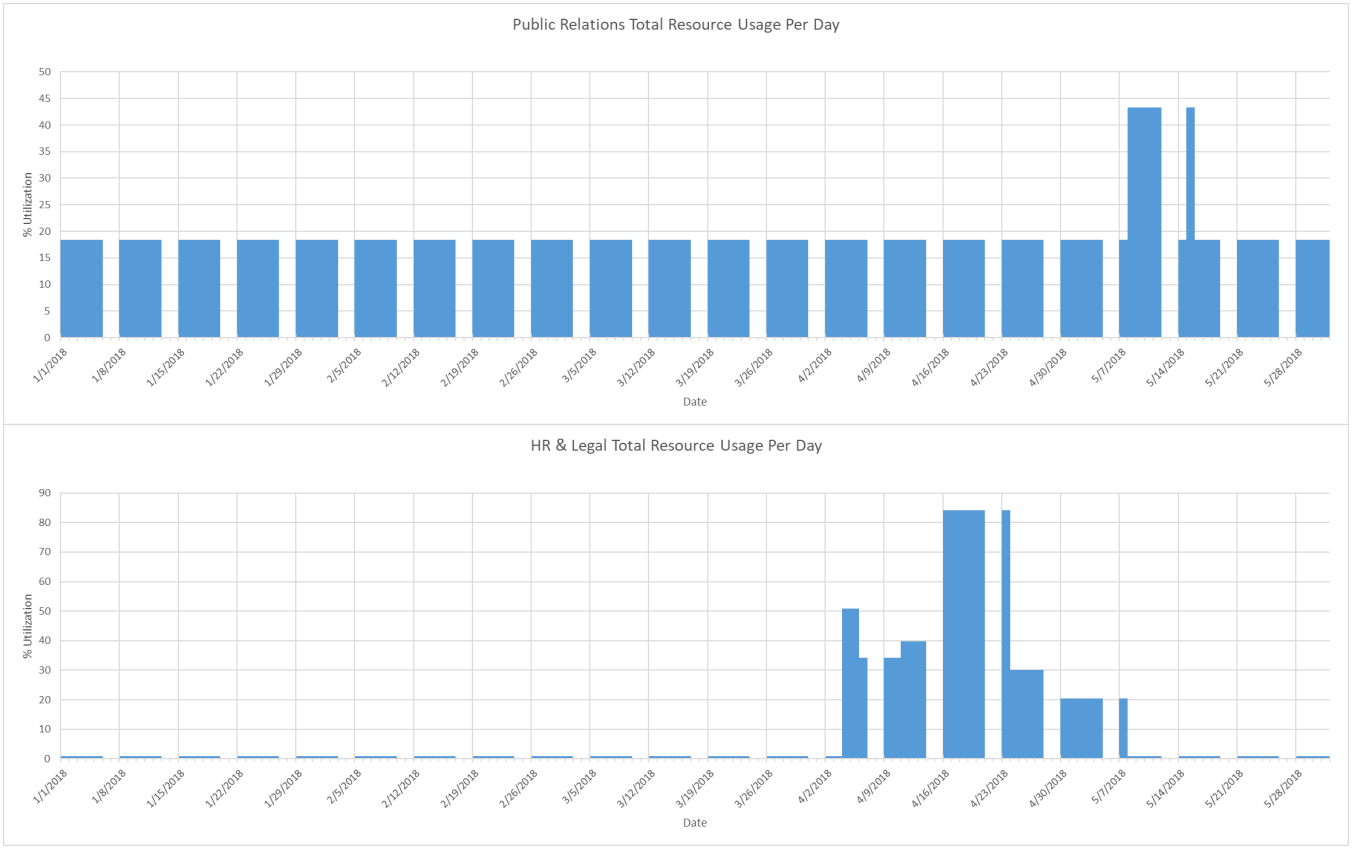



Satellite Design Total Resource Usage Per Day
% Utilization
Date

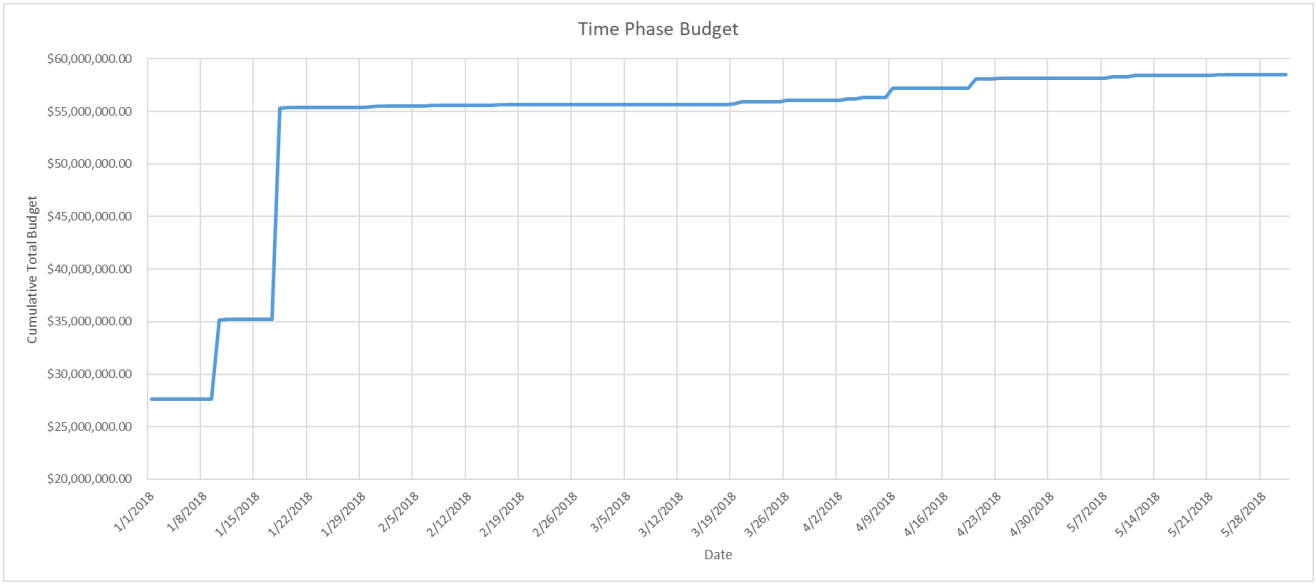

Launch Operations Total Resource Usage Per Day
% Utilization
Date


Satellite Operations Total Resource Usage Per Day
% Utilization
Date


Test Total Resource Usage Per Day
% Utilization
Date



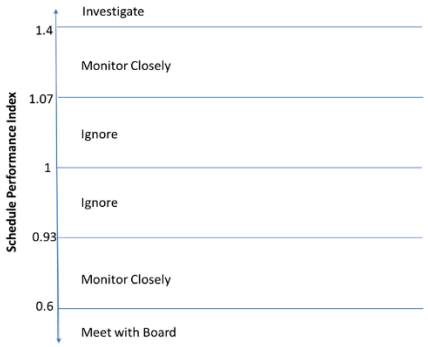
L: Time Phased Budget (Itemized table available in Excel)

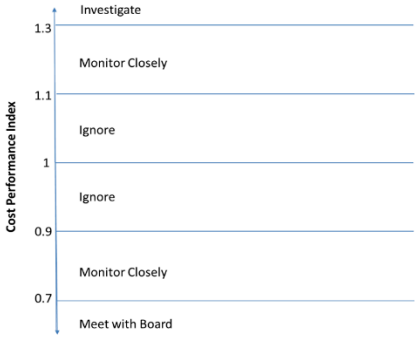


M: Monitoring and Control Systems

The project will be reviewed on a weekly basis by the PM with each of the functional managers. The schedule performance index (SPI) will be calculated based on the completed tasks in for a period of time divided by the expected completion date in the

final baseline schedule. The cost performance index (CPI) will look at the actual cost of the project every week and divide that by the time phased budget to get a value. Ignore for both charts will not be discussed in length with upper management or the functional managers for SPI or CPI. Monitor closely will require detailed reports weekly for both indexes along with a plan to get back on track. Investigate will have the PM try to discover why the index is so high and determine the root cause. Meet with board will require a meeting between management, the functional manager and the PM each week with a score in that range.





N: Project Termination – By Integration

Termination Check List		
Task	Task owner	Completion
Testing for benchmarks		
Bandwidth and latency	Test	
Battery consumption	Test	
Area coverage	Test	
Documents		
Consolidate regulatory licencse	HR and legal	
Update data sheet specifications	Satellite	
Update schedule and budget baselines	PM	
Revise risk EMV analysis	PM	
Complete final report	PM	
Deliver documents to operations PM	PM	
Collect contact information from individual contributors	PM	
Financial		
Remove resources from payroll	HR and legal	
Collect material reciepts	HR and legal	
Request funding for operations team	HR and legal	
Project Evaluation		
Report final schedule and budget performance index	PM	
Evaluate final scope	PM	
Categorize project quality of work delivery	PM	

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